The Fayetteville report: economic hazards of natural gas and local energy opportunities **for North Carolina**

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Executive summary

Locally-produced energy—solar and wind—are ready to replace North Carolina's aging coal and nuclear capacity. Mature renewable energy technology already in use around the globe give cheap, stable 24-hour coverage that is price-competitive with natural gas— without subsidies.

Local energy is also a much stronger growth driver than imported natural gas. The Atlantic Coast Pipeline (ACP) has been pitched as a jobs project; however, this claim has no bearing in economic reality and does not hold up to scrutiny. Instead the ACP will force North Carolina into dependence on imported fuels and remove $2-10 billion from the state every year, depending on natural gas prices, with minimal job creation.

Decades of experience with natural gas also show that this fuel source is prone to price spikes, outages, and costly accidents. These interruptions combined with massive cash outflows for fuel create a hostile environment for business growth.

A case study in business losses stemming directly from a state's reliance on natural gas—the California Energy Crisis of 2000-2001—is included. Supply interruptions are especially dangerous in North Carolina, where large military installations mean that power interruptions pose a threat to global military readiness. Implementing the ACP is a dead end for North Carolina energy prices and economic growth.

Meanwhile, local energy is cost-competitive without subsidies; less prone than natural gas to outages from accidents and extreme weather; keeps money in the state and local communities; and would add nearly 14,000 accessible, permanent, full-time jobs to the economy of North Carolina. Local energy is a sustainable energy supply.

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I. Solar & wind are cheaper than natural gas— without subsidies

Unsubsidized local energy— solar and wind— has been cheaper than natural gas in North Carolina since 2015[1]. Figure 1 below shows the lowest-cost energy source, without subsidies, in each county. In 77 of North Carolina's 100 counties, that lowest-cost source is solar or wind[1].

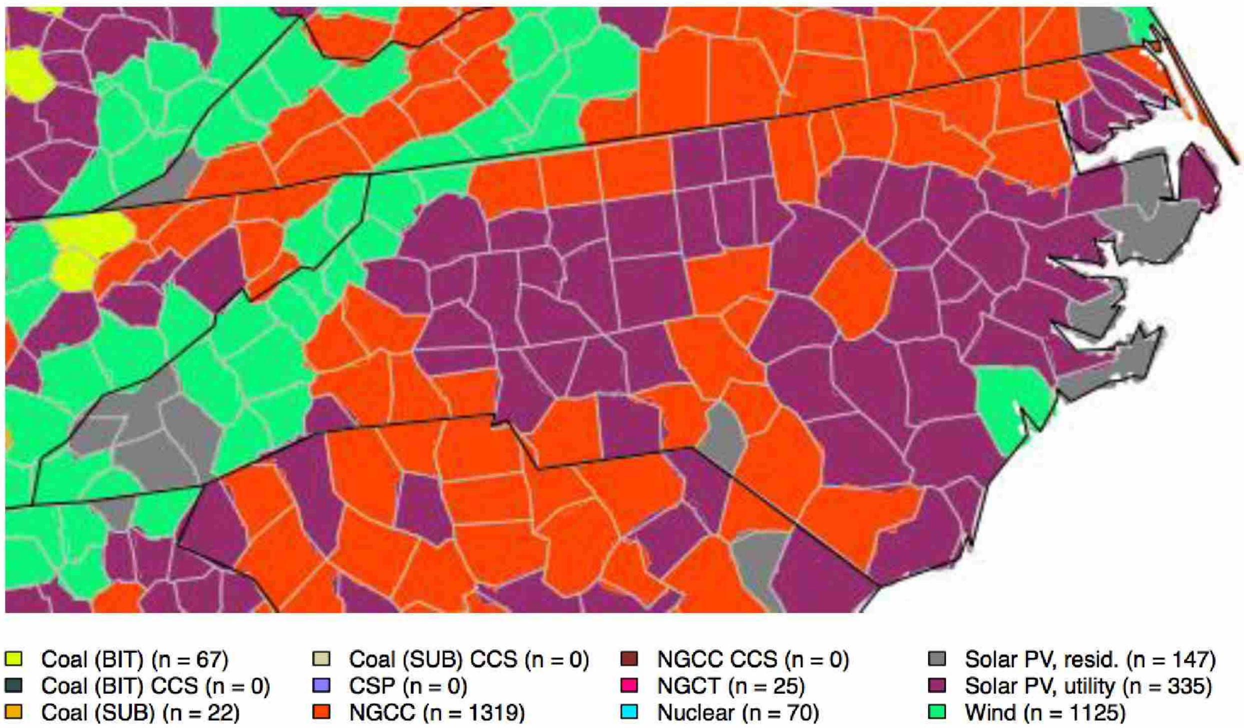

Figure. 1: Lowest-cost energy sources in each county of North Carolina. Solar (purple, grey) and wind (green) are the cheapest energy source in 77 of North Carolina's 100 counties[1]. These calculations do not include subsidies, tax credits, or externalities (e.g. pollution-related costs such as increased healthcare, the need to treat drinking water, etc). These figures are simply the bare cost of generating electricity by different methods.

The figures shown in this map were assembled in 2015 by energy analysts at the University of Texas—a state with heavy investment in natural gas— and found natural gas to be non-competitive with local energy in the majority of North Carolina. Wind and solar have been the true, unsubsidized, lowest-cost source of power in North Carolina for nearly two years. This is despite natural gas prices being at historical lows during those last two years.

This map also does not include the cost of firming (or adding utility-scale energy storage to ensure 24/7 grid coverage). Solar and wind are still competitive with natural gas even after accounting for firming. This is shown in detail in Figure 4.

While wind is a low-cost source of energy, it is not covered in this brief due to the short-term moratorium on wind development in North Carolina. The remainder of the brief will focus on solar energy; with the understanding that many of the cost computations and local economic benefits of solar apply to wind as well.

II. Future price outlook for natural gas

Natural gas prices are currently at historical lows. New technologies have lowered the breakeven cost. Meanwhile, market distortions such as overbuilding have forced wholesalers to move natural gas at or below that breakeven cost, around $2.50-3/Mcf.

In other words, natural gas *cannot get cheaper*.

Natural gas can, however, get much more expensive—quickly and without warning. The natural gas market is characterized by demand/supply swings and price shocks. Figure 2 shows a history of US natural gas prices (generally set by the price at Henry Hub distribution point in Louisiana). Even after the advent of fracking—looked to as a source of cheap, abundant, reliable natural gas—prices have fluctuated wildly from $3 to $6 to $13/Mcf and above.

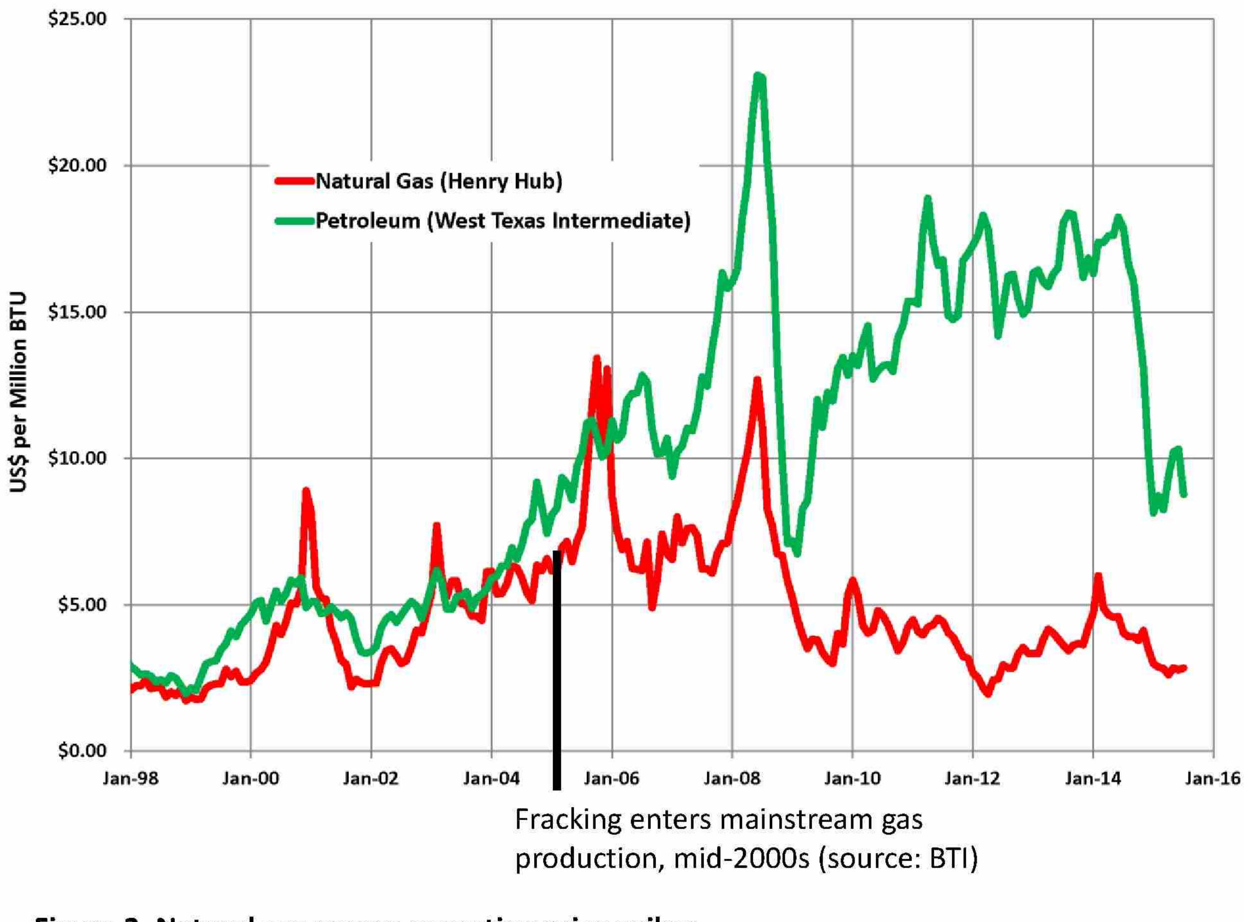

Figure 2. Natural gas means accepting price spikes.

The effect of gas price swings on electricity cost is shown below in rows 2-3 of Figure 3. Current North Carolina retail electricity costs are approximately $0.10/kWh, or $100/MWh, shown in row 1. Cost comparisons with local energy—focusing on solar due to the moratorium on wind in North Carolina—are in rows 4-9. Rows 6-9 include the cost of firming, or adding utility-scale battery storage to supply the grid during nighttime and poor generating weather.

Figure 3. Energy cost comparison, table

	Energy source	$/MWh
1	Current NC rates	$60-104[2]
2	Natural gas combined cycle	$59-129[3]
3	NC combustion turbine	$101-171[3]
4	Solar + incentives	$37-50[3]
5	Solar, no incentives	$56-81[3]
6	Solar + Li battery + incentives	$44-62[3]
7	Solar + Li battery, no incentives	$69-102[3]
8	Solar + V battery + incentives	$62-75[3,4]
9	Solar + V battery, no incentives	$81-106[3,4]

Important note: the variation in solar prices (shown by light blue caps and multiple bars for solar) are caused by different installation systems and types of financing. In other words, **once a solar system is built, its price is set**. There are no fluctuating fuel prices; day/night power variation is steady and predictable down to the minute, allowing businesses to plan their activities; and local conditions such as cloudy weather do not pose a significant hazard for a statewide grid equipped with battery backup[5,6]. In fact, distributed power production like solar and wind are more resilient to extreme weather—currently the #1 cause of US power outages—than fossil fuel production, where loss of a single transmission line can cut service to large areas[7].

All-weather reliability and stable prices allow businesses and homeowners to plan ahead with confidence. In contrast, electricity based on natural gas means unpredictable prices during good weather and outages during bad, hindering business operations, planning, and expansion.

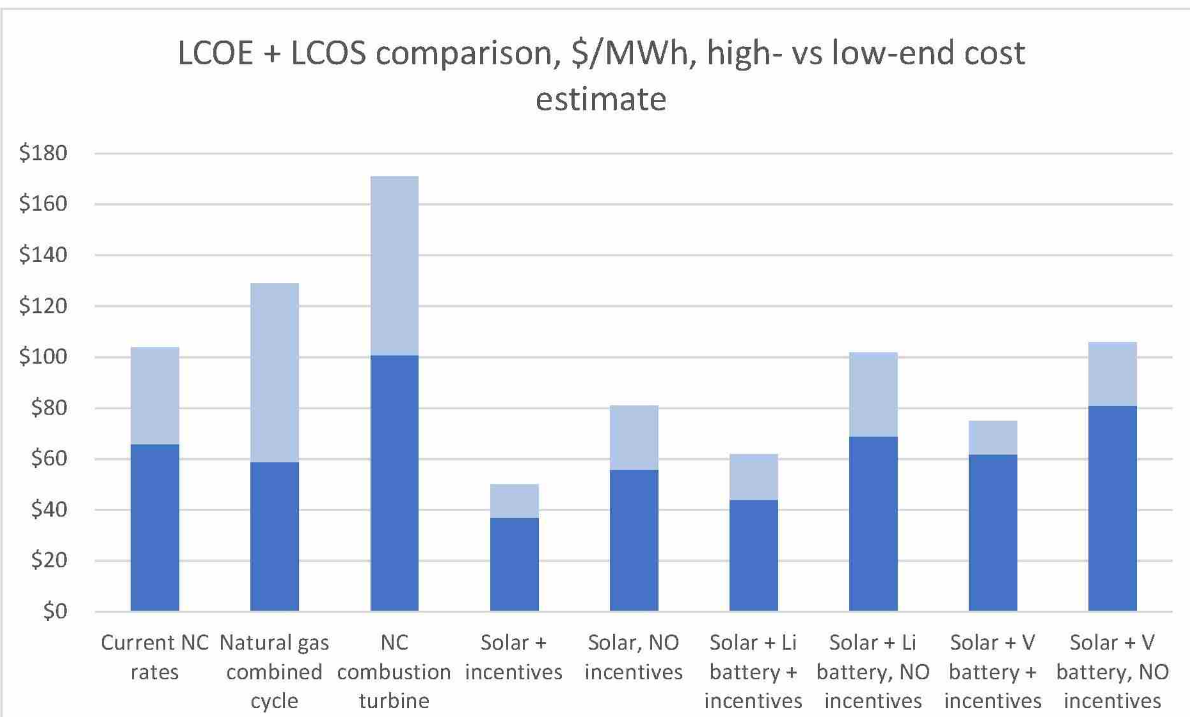

Figure 4. Energy cost comparison, bar graph

III. Natural gas price shocks bring even higher spikes in electricity costs

Electricity demand is inelastic— it drops very little in response to price increases—since it is used for time-sensitive functions like refrigeration, HVAC, industrial processes, etc. The result is drastic price spikes[8]. In states that adopted natural gas as their main grid power supply, gas supply and demand fluctuations have driven costs up to an inflation-adjusted average of \$350/MWh[9] over large regions, for a period of weeks or months. During peak hours of these gas price shocks, spikes up to \$1400/MWh[10,11], or \$1,973/MWh in today's dollars, have been seen. A case study of the California Energy Crisis of 2000-2001—which was largely the result of reliance on natural gas—is covered in section IV.

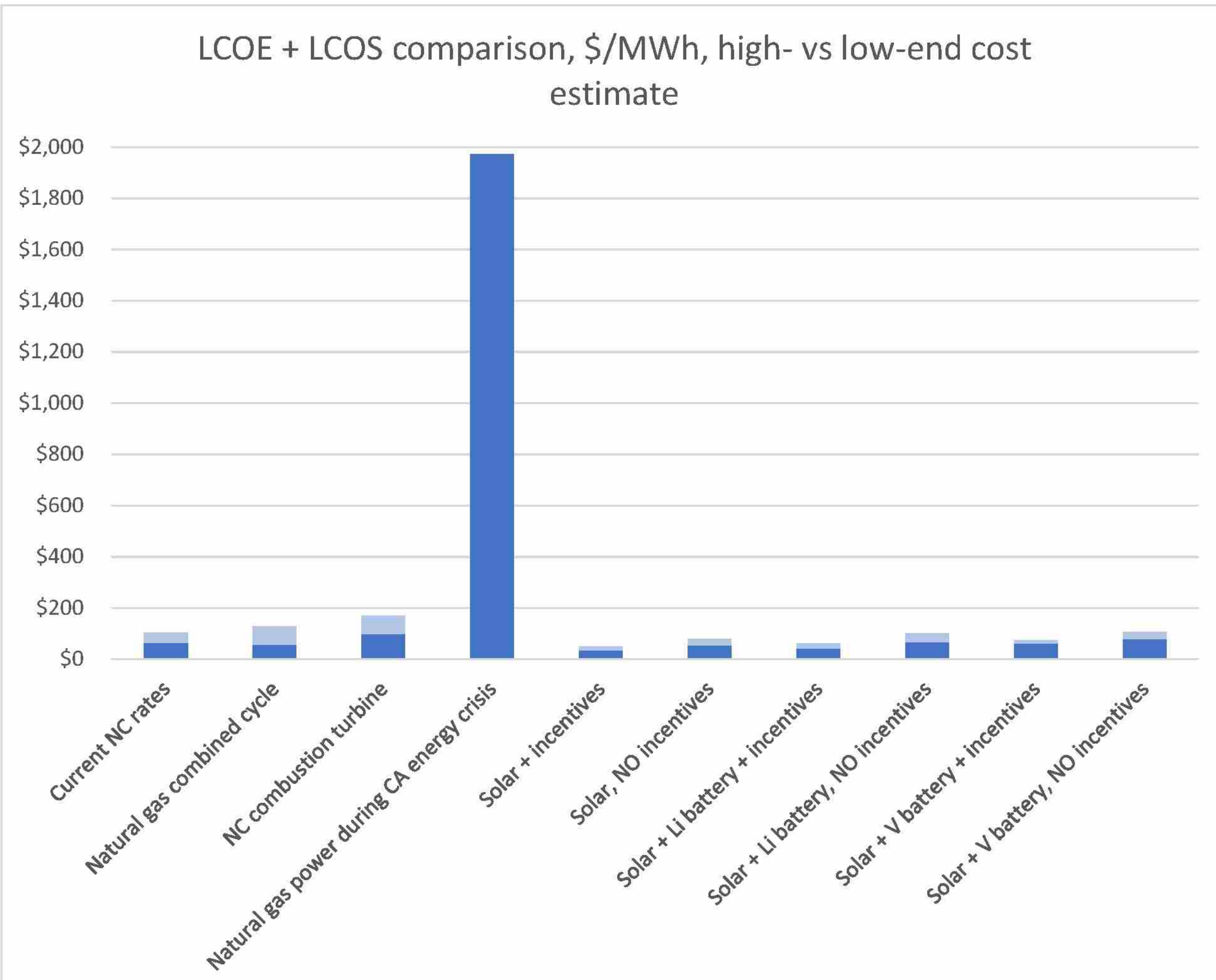

Figure 5. Moderate natural gas price shocks can bring extreme spikes in electric costs.

A natural gas-based energy future for North Carolina is a hostile environment for business growth. These price shocks bring extreme unpredictability into business operations that can be devastating. Businesses cannot plan for expansion, hiring, investing in new equipment, or opening new locations without a stable cost outlook.

IV. Low-cost, reliable energy alternatives for North Carolina

In spite of the environmental challenges that coal, nuclear, and natural gas pose, North Carolina's priority need is stable, low-cost, 24-hour electricity.

With recent price drops in generating units and grid-scale energy storage, solar and wind are ready to fill that need. Solar and wind have three key advantages for grid performance:

1) Competitive price— *even after subtracting subsidies, and adding energy storage costs.*

2) Reliable, stable price— compared to natural gas which forces price shocks onto ratepayers.

3) Local power— natural gas forces North Carolina to pay out-of-state for energy. Solar and wind can be generated in-state with local workers and manufacturing capacity, **adding up to $12B in North Carolina's economy every year.**

Points 1 and 2 are covered in sections I-III. The third point— opportunities for strong economic growth in North Carolina by using local energy— is discussed below.

V. Local power keeps money in North Carolina

Pipelines are a two-way street: gas flows in, in exchange for dollars flowing out.

North Carolina has no natural gas resources. Any strategy relying on natural gas locks the state into dependence on imports, and into shipping money out of the state just to keep the lights on—no matter what the price.

Natural gas price-- $/Mcf	Natural gas price-- $/MWh	Cash outflows to cover fuel costs
$2.50 (breakeven for drilling)	**$18.48**	**-$2.37 billion**
$3 (current natural gas cost)	**$22.17**	**-$2.85 billion**
$4	**$29.57**	**-$3.80 billion**
$5	**$36.96**	**-$4.74 billion**
$6	**$44.35**	**-$5.69 billion**
$7	**$51.74**	**-$6.64 billion**
$8	**$59.13**	**-$7.59 billion**
$9	**$66.52**	**-$8.54 billion**
$10	**$73.92**	**-$9.49 billion**
$11	**$81.31**	**-$10.44 billion**
$12	**$88.70**	**-$11.39 billion**
$13	**$96.08**	**-$12.34 billion**

Figure 6. ACP outlook: natural gas cash outflows from North Carolina at different price points. Current natural gas prices (about $3/Mcf) highlighted.

Economists and ratepayers have long taken for granted that electric bills are a sunk cost— a necessary price for living and doing business—and that that money departs to areas that produce fuel. A natural gas strategy takes advantage of this ingrained habit. Again, this strategy is a losing one for North Carolina as it has no sources of natural gas.

However, solar and wind are cheap and abundant in North Carolina. With affordable units and grid-scale batteries now available, renewables aren't just competitive—they're an engine for statewide economic growth. These opportunities are especially strong in less urbanized areas with affordable land and simple permitting processes, which have historically struggled the most to find opportunities for growth.

A brief example of statewide and local economic gains from a local energy is shown below. Figure 7 shows economic gains from solar for Cumberland County—a semi-developed area with access to Research Triangle energy markets—from generating its own solar energy; from exporting solar electricity for the Triangle market; and total revenues retained within the North Carolina economy from a statewide local energy strategy. This example uses $90/MWh, which is both slightly below current residential energy costs in North Carolina and a price point that is reasonably achieved with unsubsidized, battery-firmed solar (see Figure 4).

Region	Electricity usage (MWh)	$/MWh	Total electric retail expenditures
Cumberland County	2,000,000	90	$180 million
Research Triangle	26,832,432	90	$2.41 billion
North Carolina statewide	134,162,162	90	$12.1 billion

Figure 7. Case study: retail expenditures on electricity in North Carolina regions

Under a solar strategy, Cumberland County would be able to generate its own electricity and retain up to $180 million dollars in the county per year. Using conservative estimates for job creation from operating & maintaining solar panels only (not solar installation or operating battery storage), this translates into 280 permanent full-time jobs[12] in Cumberland County—a substantial economic boost. Generating electricity for the Research Triangle market could bring up to $2.4 billion and an additional 3,750 permanent full-time jobs to Cumberland County, or these solar sites and jobs may be distributed across several rural counties surrounding the Triangle.

VI. Local power builds jobs and economic growth in North Carolina

Statewide, Sustainable Sandhills calculates a local energy strategy would bring approximately 14,000 permanent, full-time jobs to North Carolina (see Figure 8). This is in line with the NC Clean Path projections[3], and is substantially higher than job growth possible with natural gas.

Energy source	Construction jobs per GWh	OM& jobs generated per GWh	GWh retailed in NC/year	Construction jobs created (person-years)	Total full-time O&M jobs
Solar	0.25[12]	0.14[12]	99,280[3]	65,525	13,899
Natural gas	0.03[12]	0.08[12]	99,280[3]	2,978	7,942

Figure 8. Construction and permanent full-time jobs in North Carolina, solar vs natural gas.

Figure 8 uses conservative estimates for solar jobs gains (lowest value for jobs/GWh from source data are used). The solar jobs figures only include installation and O&M (operations and maintenance) for the panels—not for battery installation + O&M, or for PV and battery manufacturing jobs. Actual solar job figures are likely to be higher due these factors.

Major job gains from renewable power are typical across the industry[13]. Just like pipelines and power plants, PV, wind, and batteries have both one-time installation and ongoing operations costs. However, natural gas must be constantly fed fuel. A significant portion of each dollar spent on natural gas goes directly to paying for fuel (see Figure 6)—over $2 billion worth per year at today's historical low fuel prices. In contrast, once installed, local energy needs no inputs other than maintenance by workers[14]. For this reason, a higher percentage of renewable installation costs go to salaries compared to natural gas.

Operations and maintenance jobs for renewables are tasks like cleaning, preventive maintenance, repairs, grounds-keeping to prevent brush overgrowth, etc. These are abundant, accessible, permanent blue-collar jobs. The economic growth power of local energy for North Carolina—especially its struggling rural areas—cannot be overstated.

Other considerations for job and wealth growth include the in-state construction and manufacturing base for natural gas vs solar in the state. Natural gas is a poor generator of employment in all regions, but especially for North Carolina. With no natural gas resources within its borders, this state has no base of natural gas construction workers. Welders, fitters, inspectors, manufacturers of pipeline parts, etc., must be brought in as contractors from natural gas-heavy areas like Texas and North Dakota. Most of their salaries will leave North Carolina immediately.

Meanwhile, North Carolina has a substantial in-state base of solar manufacturers and installers. These businesses employ North Carolina natives, including a high percentage of veterans who make up nearly 10% of the solar energy force nationwide[15]. A solar strategy will engage skills and resources native to North Carolina, and build wealth that will stay in and continue to drive economic growth.

VII. Case study in financial risks of a natural gas state strategy: California energy crisis, 2000-2001

Today California is a leader in local power, with about 30% of total energy[16] and 56% of energy during peak hours provided by renewables[17]. However, this was not always the case. California's local power surge came after hard lessons on the hazards of relying on natural gas.

In 1998, California began deregulating its electricity markets. The deregulation process was poorly designed, and by 2000 power shortages led to rolling blackouts and extreme hikes in power costs[11]. Investigations found that generating companies, including Enron, had deliberately gamed markets to create artificial shortages and maximize profits through the resulting price spikes[9,18,19]. Prices went as high as $1,973/MWh in 2017 dollars[10].

The crisis bled $40-45 billion dollars out of California through inflated energy costs[10]; added massive debts to the state budgets; ruined the state's credit[10]; and brought voter fury that ended the political careers of those perceived to be responsible. Most notably, then-Governor Gray Davis was ousted in a recall election due to his perceived role in the crisis.

Post-mortems of the energy crisis tend to focus on whether to blame lawmakers or private enterprise. Often neglected is that regardless of who drove the crisis, it was only possible thanks to a market dominated by natural gas.

In 2000, 50% of California's energy came from natural gas[10]. California's energy policy favored clean sources, and natural gas was the cleanest economical option available 20 years ago.

However, natural gas also played a key role in pushing California into a crisis. Natural gas has unique traits including:

• Heavy price fluctuations. See Fig.1—due to normal supply/demand variations, US natural gas prices jumped from approx. $3/Mcf to nearly $9/Mcf. This meant half the state's energy supply was captive to a source that had tripled in price, which neither regulators nor private market participants had any ability to counteract.

• Fragile supply chains. Cheap natural gas needs an infrastructure of a few large, arterial pipelines. (In contrast, coal can be carried on any railroad or cargo vessel; nuclear plants need refueling only once every 18-24 months; and wind and solar need no fuel at all.) This infrastructure is extremely fragile. A single breakdown or accident can cut gas flows—and thus electricity—across a broad area. This vulnerability contributed to California's energy meltdown. A deadly New Mexico pipeline explosion on August 19, 2000 shut off 15% of California's natural gas supply[10]. This raised gas prices in California, on top of the US-wide price increase.

• Prone to deliberate market tampering. Natural gas power plants can shut down and restart fairly quickly compared to coal and nuclear. This is typically an advantage, as it allows natural gas plants to respond quickly to changes in demand. This is in contrast to coal and nuclear plants, which once online must stay running.

However, in a poorly designed market, natural gas plants' agility can be a liability. Recorded phone calls demonstrated an OPEC-like collaboration between energy suppliers to drive up prices[9,18,19]. In some cases, energy traders called natural gas power plants and requested unnecessary shutdowns during the crisis peak to further inflate prices, as this recording[19] shows:

"This is going to be a word-of-mouth kind of thing," Mr. Williams says on the tape. "We want you guys to get a little creative and come up with a reason to go down." After agreeing to take the plant down, the Nevada official questioned the reason. "O.K., so we're just coming down for some maintenance, like a forced outage type of thing?" Rich asks. "And that's cool?" "Hopefully," Mr. Williams says, before both men laugh.

These efforts succeeded in exaggerating natural price shocks. Ratepayers paid out nearly $2,000/MWh[10] (adjusted for inflation) during the height of the crisis.

This type of market interference requires a power source that can be brought on- and offline at will. In other words, it only works in natural gas-dominated markets. Deliberate price inflation through temporary plant shutdowns is not possible with coal, nuclear, wind, or solar. Deliberate tampering is a market threat that is unique to natural gas.

California's experience carries important lessons for North Carolina.

1. An energy strategy that depends on imports is a poor strategy. California has extensive natural gas fields within its borders, although not enough to supply state demand. Meanwhile, North Carolina has none. A natural gas strategy locks the entire state of North Carolina into dependence on one or two pipeline arteries carrying imported natural gas.

2. Regardless of whether gas originates in- or out-of-state, natural gas supply chains are dangerously fragile. A single incident can spark months of supply shortages and elevated prices. This is especially serious considering the large military presence in North Carolina. A single supply interruption in the state can threaten defense readiness around the globe.

3. Poor market design enables manipulation. North Carolina has the poorest market design of all—a monopoly.

Duke Energy—a major shareholder in the ACP, and North Carolina's sole power producer— was "near the top of the list of companies accused of overcharging" in the California crisis[20]. Enabling a company with a track record of manipulating markets—especially in a region where it already enjoys a monopoly—is courting serious danger. And while the California crisis took place nearly twenty years ago, Duke has shown itself ready to exploit its monopoly status in today's North Carolina as well.

In a recent trial over negligent waste handling, Duke's defense reminded the court that—due to federal statues prohibiting the US Department of Defense (DoD) from purchasing from convicted felons, and Duke's monopoly status in North Carolina—a guilty finding would result in

an immediate and total shut off of electricity to Fort Bragg and Camp LeJeune[21].

Implementing the Atlantic Coast Pipeline would result in near total energy dependence on natural gas in North Carolina, and if the economics and lessons of the California energy crisis history as our guide, it becomes clear that the rate payers, workers, and businesses of North Carolina will not benefit.

Conclusion

The Atlantic Coast Pipeline (ACP) brings unacceptable risks for business and military readiness in North Carolina. Supply interruptions, price spikes, outages, and even deliberate price manipulation are all established consequences of reliance on natural gas.

Meanwhile, solar and wind are now mature technologies. They are cost-competitive without subsidies, and can power a grid 24/7. Renewable local energy creates more jobs per megawatt-hour than imported natural gas, bringing better economic growth than natural gas without additional costs.

The Atlantic Coast Pipeline is an economic hazard – an ineffective and outdated energy source with harmful financial costs for North Carolina. Local energy lets the state look forward—to growth, military-friendly energy independence, thriving businesses, and abundant, accessible, permanent jobs.

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Appendix: Miscellaneous local power concerns for North Carolina

• Fears of interference with military operations: The US Department of Defense (DoD) has a clearinghouse specifically to assist local energy projects, with a web portal at https://www.acq.osd.mil/dodsc/. DoD has approved the vast majority of renewable energy projects that have applied, showing that local energy and military operations are compatible[22]. Furthermore, fears of interfering with military operations ignore the fact that much of the world is adopting local energy. To maintain global readiness in today's world, the US military must develop tools and training that operate in conjunction with wind and solar energy generation, and is proactively doing so. Banning wind and solar does nothing to help military readiness.

• Fears of losing farmland to solar development: North Carolina has quadruple the amount of area needed to supply North Carolina's electricity in urban rooftops, parking lots, and brownfields alone[23]. No use of rural land is needed.

That said, solar power can be an important bulwark against farm loss. Farms that add solar power typically do so on only part of their land. Most farms have some acreage that has always yielded poorly. These fields—not good farmland—are the sections that are transformed into solar, since the yield loss from converting them is negligible.

These once poor-yielding areas then give steady returns to farm families, even in years when crops or prices are poor. Generally farm families' only option in times of crisis has been to sell off land to real estate development—the number-one cause of farmland loss in the US[24]. By acting as an economic anchor in bad years, solar fields can be a key to slowing farm loss and preserving productive crop land.

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